

Project: Impact of transmission type on fuel efficiency

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Executive Summary

In this analysis the effect of transmission (manual or automatic) on fuel efficiency is evaluated. The analysis shows that manual transmission leads to a better mileage than automatic transmission. And the model that shows the best fit is the one that has factors transmission, vehicle weight, and quarter mile time.

Data Processing

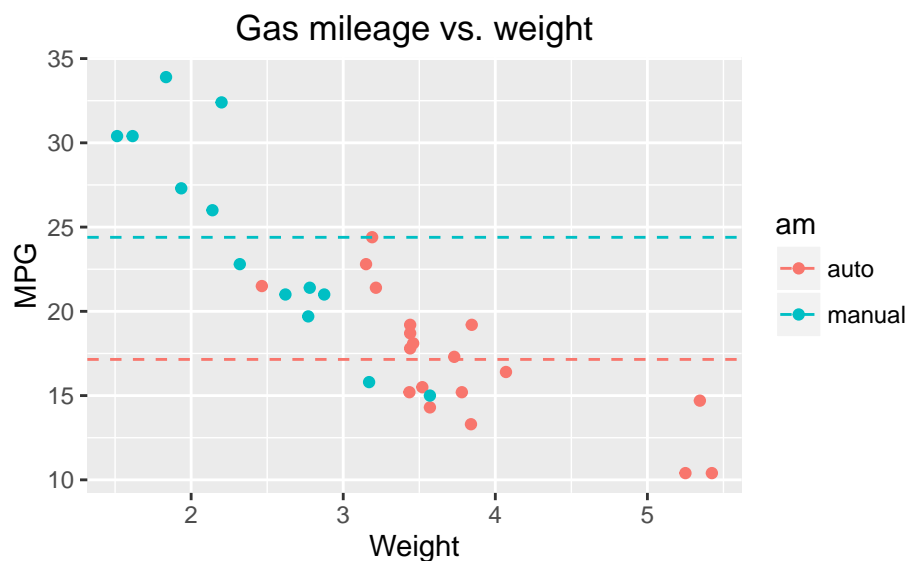
The collected data (Appendix A - Table 1) consists of 32 automobile models with some of their characteristics measured.

Two questions must be answered:

Is an automatic or manual transmission better for MPG?

Quantify the MPG difference between automatic and manual transmissions.

Exploratory data analysis



In the chart above is shown that the mean gas mileage of cars with manual transmission is higher compared to cars with automatic transmission. It can also be seen that there is a negative correlation between the fuel efficiency (gas mileage) and the weight of the vehicle. So other factors must be considered in the fitting model in order to have a better understanding of the impact of transmission on fuel efficiency.

Multivariate Regression

According to Henderson and Velleman (1981) the best fit occurs with the variables transmission type (AM), weight (WT), and quarter mile time (qsec). The table 01 shows the coefficients of the model with those regressors.

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	9.62	6.96	1.38	0.178
ammanual	2.94	1.41	2.08	0.047
wt	-3.92	0.71	-5.51	0.000
qsec	1.23	0.29	4.25	0.000

But let's compare with a model where all factors are predictors.

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	12.30	18.72	0.66	0.518
cyl	-0.11	1.05	-0.11	0.916
disp	0.01	0.02	0.75	0.463
hp	-0.02	0.02	-0.99	0.335
drat	0.79	1.64	0.48	0.635
wt	-3.72	1.89	-1.96	0.063
qsec	0.82	0.73	1.12	0.274
vsstraight	0.32	2.10	0.15	0.881
ammanual	2.52	2.06	1.23	0.234
gear	0.66	1.49	0.44	0.665
carb	-0.20	0.83	-0.24	0.812

The Analyse of Variance for the model with only 3 regressors and the model with all of them.

	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1	28	169.29				
2	21	147.49	7	21.79	0.44	0.8636

Notice that RSS for model2 provides a better Rsquared but the overall P value is large, the data do not give any reason to conclude that the means differ and indicates that this could constitute overfitting.

The quality of the fit can be evaluated using the residual and Q-Q plots (Appendix B). In the residuals chart there is no visible pattern so it can be said that the residuals are normally distributed and homoscedastic. In the Q-Q chart most of the points lie on the line $y = x$, showing that the model is fitting the data.

Conclusions

As shown the best model is the one with the variables Transmission, Weight, and Quarter Mile Time.

$$\text{mpg}_i = \beta_0 + \beta_1 \text{am}_i + \beta_2 \text{wt}_i + \beta_3 \text{qsec}_i$$

The coefficient `ammanual` quantifies the effect of the transmission type when weight and 1/4 mile time has been adjusted for. The P value is less than 0.05 (Table 1), so we conclude that, with a 95 % probability, `ammanual` differs from zero and the gas mileage difference between manual and automatic transmissions is a significant factor. According to our model, using a manual transmission as opposed to automatic leads to a 2.94 mpg increase in the gas mileage. The confidence interval for this analysis is [0.05 5.83]. In other words, the manual transmission shows better mileage than the automatic transmission.

Sources

- Brian Caffo, "Regression Models for Data Science in R" (2015).
- Harold V. Henderson and Paul F. Velleman, "Building Multiple Regression Models Interactively," *Biometrics* **37** (1981), pp. 391–411. <http://www.jstor.org/stable/2530428>

Source code

Complete R Markdown source is available in GitHub: https://github.com/RUSCZAK/Regression_Models_Coursera

Appendix A

Table 1: (1973-74) models)

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21.00	6.00	160.00	110.00	3.90	2.62	16.46	v	manual	4.00	4.00
Mazda RX4 Wag	21.00	6.00	160.00	110.00	3.90	2.88	17.02	v	manual	4.00	4.00
Datsun 710	22.80	4.00	108.00	93.00	3.85	2.32	18.61	straight	manual	4.00	1.00
Hornet 4 Drive	21.40	6.00	258.00	110.00	3.08	3.21	19.44	straight	auto	3.00	1.00
Hornet Sportabout	18.70	8.00	360.00	175.00	3.15	3.44	17.02	v	auto	3.00	2.00
Valiant	18.10	6.00	225.00	105.00	2.76	3.46	20.22	straight	auto	3.00	1.00
Duster 360	14.30	8.00	360.00	245.00	3.21	3.57	15.84	v	auto	3.00	4.00
Merc 240D	24.40	4.00	146.70	62.00	3.69	3.19	20.00	straight	auto	4.00	2.00
Merc 230	22.80	4.00	140.80	95.00	3.92	3.15	22.90	straight	auto	4.00	2.00
Merc 280	19.20	6.00	167.60	123.00	3.92	3.44	18.30	straight	auto	4.00	4.00
Merc 280C	17.80	6.00	167.60	123.00	3.92	3.44	18.90	straight	auto	4.00	4.00
Merc 450SE	16.40	8.00	275.80	180.00	3.07	4.07	17.40	v	auto	3.00	3.00
Merc 450SL	17.30	8.00	275.80	180.00	3.07	3.73	17.60	v	auto	3.00	3.00
Merc 450SLC	15.20	8.00	275.80	180.00	3.07	3.78	18.00	v	auto	3.00	3.00
Cadillac Fleetwood	10.40	8.00	472.00	205.00	2.93	5.25	17.98	v	auto	3.00	4.00
Lincoln Continental	10.40	8.00	460.00	215.00	3.00	5.42	17.82	v	auto	3.00	4.00
Chrysler Imperial	14.70	8.00	440.00	230.00	3.23	5.34	17.42	v	auto	3.00	4.00
Fiat 128	32.40	4.00	78.70	66.00	4.08	2.20	19.47	straight	manual	4.00	1.00
Honda Civic	30.40	4.00	75.70	52.00	4.93	1.61	18.52	straight	manual	4.00	2.00
Toyota Corolla	33.90	4.00	71.10	65.00	4.22	1.83	19.90	straight	manual	4.00	1.00
Toyota Corona	21.50	4.00	120.10	97.00	3.70	2.46	20.01	straight	auto	3.00	1.00
Dodge Challenger	15.50	8.00	318.00	150.00	2.76	3.52	16.87	v	auto	3.00	2.00
AMC Javelin	15.20	8.00	304.00	150.00	3.15	3.44	17.30	v	auto	3.00	2.00
Camaro Z28	13.30	8.00	350.00	245.00	3.73	3.84	15.41	v	auto	3.00	4.00
Pontiac Firebird	19.20	8.00	400.00	175.00	3.08	3.85	17.05	v	auto	3.00	2.00
Fiat X1-9	27.30	4.00	79.00	66.00	4.08	1.94	18.90	straight	manual	4.00	1.00
Porsche 914-2	26.00	4.00	120.30	91.00	4.43	2.14	16.70	v	manual	5.00	2.00
Lotus Europa	30.40	4.00	95.10	113.00	3.77	1.51	16.90	straight	manual	5.00	2.00
Ford Pantera L	15.80	8.00	351.00	264.00	4.22	3.17	14.50	v	manual	5.00	4.00
Ferrari Dino	19.70	6.00	145.00	175.00	3.62	2.77	15.50	v	manual	5.00	6.00
Maserati Bora	15.00	8.00	301.00	335.00	3.54	3.57	14.60	v	manual	5.00	8.00
Volvo 142E	21.40	4.00	121.00	109.00	4.11	2.78	18.60	straight	manual	4.00	2.00

[1] mpg Miles/(US) gallon

[2] cyl Number of cylinders

[3] disp Displacement (cu.in.)

[4] hp Gross horsepower

[5] drat Rear axle ratio

[6] wt Weight (1000 lbs)

[7] qsec 1/4 mile time

[8] vs Engine type V or Straight

[9] am Transmission (0 = automatic, 1 = manual)

[10] gear Number of forward gears

[11] carb Number of carburetors

Appendix B

